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# Yield maximization of rice through site specific nutrient management

**Tripathi BN**✉, **Singh RK**, **Arvind Kumar**, **Mishra SK**, **Aslam**

Rice Chemistry Section, All India Coordinated Research Project on Rice, C. S. Azad University of Agriculture and Technology, Kanpur-208002 (U.P.) India

✉**Correspondence author:**
Rice Chemistry Section, All India Coordinated Research Project on Rice, C. S. Azad University of Agriculture and Technology, Kanpur, India
Email: dr.bnt1957@gmail.com

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## ABSTRACT

In order to maximize the rice productivity, biomass accumulation, nutrient concentration along with uptake in relation to soil supply capacity of plant nutrients and their management for developing fertilizers prescription to achieve realizable target yields based on particular field observations. Determination of nutrients requirement for recommendation of yield targeted to bridge the gap in such type of agro-climatic condition. Taking this fact in view present investigation was planned and conducted during three consecutive year 2014-15 to 2016-17 to evaluate the response of various treatments on rice NDR-359. Results achieved from the experiments revealed that maximum grain and straw yields, yield component viz. tillers $m^{-2}$, panicles $m^{-2}$, filled grains panicle$^{-1}$, length of plant and panicles, along with panicle weight in that plot which received fifty percent nitrogen with full doses of phosphorus, potassium, zinc, iron and manganese as basal at transplanting of rice seedling and remaining half nitrogen on the basis

of leaf color chart under SSNM through nutrient expert recommendations ($T_3$) followed by SSNM ($T_2$). RFD ($T_1$) and farmers fertilizers doses ($T_8$). Test weight of 1000-grain of rice showed reverse trend that yield and yield components of rice. Biomass accumulation markedly enhanced as plant growth increased. The yield and yield attributing characteristics recorded lowest value in absolute control condition. Omission of nitrogen, phosphorus and potassium alone in particular plot noticed decreasing effect on their concentration and uptake by rice grain and straw resulting lower yield of grain and straw of rice than that recommended doses of fertilizer and site specific nutrient management. The concentration and uptake of various nutrients by rice grain and straw showed similar trend under the influence of various treatments. It is obvious from results that imbalance use of fertilizer nutrients by farmers might be reduced production potential, biomass accumulation in rice plants at both 30 & 60 DAT in this agro-technique. Maximum net return Rs. 44075 $ha^{-1}$ with B:C ratio 2.6 was recorded in that condition in which 50% N with full dose of P, K, Zn, Fe and Mn were applied as basal at the time of transplanting of rice seedling and remaining N in two equal splits according to leaf color chart ($T_3$) followed by $T_2$ and $T_1$. Lowest net return Rs. 2312 with B: C ratio 0.6 was found in control plot ($T_7$).

**Keywords:** Grain and straw yield, yield attributes, nutrient concentration, uptake, biomass accumulation, rice and soil health

## 1. INTRODUCTION

Rice (*Oryza sativa*. L) is the most important staple food crop in the world as well as in 1ndia and plays a major role in India economy. It occupies highest area among the crop grown in the country. Rice production accounted for 43.5 percent of total cereal production and 40.6 percent of total food grain production in our country. The projected requirement of rice by the year 2050 for consumption purpose alone is 136 million tons for- an expected population of 162 million. Since the scope to bring additional areas under rice cultivation is limited; the increase in production has to come from less land the production of rice was 104.4 million ton in 2013-14 (Tripathi *et al.,* 2018). The demand for rice is expected to grow faster than the population. The per capita consumption of rice in India is around 180 gm /day. Indian population is growing at a rate 1.41 percent per annum hence to sustain the food security and to meet the requirements of growing population, it is essential to raise the yield levels, despite the concerted research and collaboration. The problem of wide gaps between potential and actual yield persist, it appears that the potential of green revolution strategies has been almost reached. In the next three decades, farmers need new approaches and technologies to produce 50-60 percent more rice on existing the word rice production was 463 million tons while that of India was 104.4 million tons during 2013-14 India share in global rice production has been hovering at 19-23 percent. The area under rice in India was 43.86 million hectares with a production of 104.4 million tons and productivity of 2.462 t $ha^{-1}$ during aforesaid period India as no.1 exporter of rice was able to export 3.76 million ton of basmati rice and 7.13 million ton of non basmati rice in 2013-14. Rice production in 2016 kharif registered a remarkable growth, despite of three percent deficient rainfall. The total rice production as per second advanced estimate is a record 96.02 million tonnes well above the target 93 million tonnes and 5 percent higher as compared to 2015 kharif (Tripathi *et al.* 2016).

Nitrogen is the essential plant nutrient which influences plant growth and production; it is a structural constituent of cell. It helps in building of vegetative part of plants and assists in the utilization of other nutrient like P and K in cereals and plays an important role in metabolism by virtue and being an essential constitute of diverse types of metabolic active compounds like nucleic acid, co-enzymes and alkaloids. Due to deficiency of nitrogen the crop growth is badly affected. Foliage turns yellowish causes shriveling of grains and ultimately decreases crop yield. Excess of nitrogen causes vigorous vegetative growth and delays maturity. Increased the proportion of straw to grain and decreased cell wall thickness.

Phosphorus is second next to nitrogen and one of the important major plant nutrients for crop production. Its effect is very widely on crop production and plant growth. It plays significant role in photosynthesis, respiration, energy storage and transfer cell division, cell enlargement and several other process in plant, it promotes early root formation and growth. It is involved in the transfer of heredity traits from one generation to the next. So phosphorus is called 'The key of life'. Phosphorus has been also called as the 'Bettie neck of world hungers. Deficiency of phosphorus results in disturbing the nitrogen metabolism, which is evident as accumulative of soluble organic nitrogen. Nitrogenous compounds of amino acids and amides and decrease protein content (Tripathi *et al.,* 2016).

Potassium one of the major plant nutrients plays a important role in the maintenance of cellular organization by regulation the permeability of cell wall by stabilizing the emulsion of high colloidal properties. In deficient condition it reduces photosynthesis and increased respiration and lower plant carbohydrate supply. It is essential for protein synthesis it helps to control ionic balance and translocation of heavy metals.

Zinc aids synthesis of plant growth substances and enzyme systems is essential for promoting certain metabolic reaction. Thus, it is necessary for production of chlorophyll and carbohydrates. Zinc is moderately mobile within the plant, so symptoms first appear on the younger leaves. Symptom of Zn deficiency in rice crop is bronzing of leaves and is called Khaira disease. Fertilizer plays a crucial role in increasing crop productivity through their judicious application by increasing the supply of deficient plant nutrients in soil. Farmers in general, are applying generalized quantities of nitrogen, phosphorus and to some extent potassium with the rest deficiency of other nutrients are spreading in space and with increasing level of soil nutrient depletion and higher demand of food grain production in further the nutrient use will have to be increased at higher level. No doubt, chemical fertilizer due to definite place in soil fertility and management with fertilizer is necessary for sustaining responses of chemical fertilizer and maintains soil health (Sharma *et al.,* 2013 and Tripathi *et al.,* 2010).

Intensive cultivation, growing exhaustive crop use of imbalance and in adequate fertilizers accompanied by restricted use of organic manure and bio-fertilizer have made the soil not only deficient in nutrient but also deteriorate soil health along with microbial activities Under such situation, integrated plant nutrient systems (IPNS) has assumed great importance for the maintenance of soil productivity. Green manure and FYM not only supply micronutrient but also meet the requirement of micronutrient in sufficient quantity to the crops, reduce production cost and improve soil health. The conventional blanket fertilizer recommendation causes low fertilizer use efficiency and imbalanced use of fertilizers. Estimation of field specific fertilizer requirements needs site specific knowledge of crop nutrient requirement indigenous nutrient supply and recovery efficiency of applied fertilizer. The aim of SSN M is to apply nutrients at optimal rates and times to achieve high yield and high efficiency of nutrient use by rice crop. Keeping the above facts in view the present investigation entitled 'Yield maximization of rice through site specific nutrient management' was planned and conducted during kharif 2014 to 2016.

## 2. MATERIALS & METHODS

The present investigation was planned and conducted during kharif season of 2014 to 2016 in a fixed layout in sandy loam soil of Oil Seed Research Farm, Kalyanpur, C.S. Azad University of Agriculture and Technology, Kanpur (U.P.). The initial physico-chemical and mechanical characteristics of the experimental soil were sand 56.87%, silt 22.92% and clay 20.21%, pH 7.85%, E.C. 0.75 $dSm^{-1}$, CEC 24.8 Cmol ($p^+$) $Kg^{-1}$, Organic carbon 4.5 g $Kg^{-1}$, bulk density 1.22 mg $m^{-3}$, particle density 2.65 mg $m^{-3}$, porosity 48.2%. The texture of soil was sandy loam under inceptisol taxonomical class having available N, $P_2O_5$, $K_2O$ 235, 19.5, 165 Kg $ha^{-1}$, respectively. DTPA extractable Zn, was - 0.28 mg $Kg^{-1}$, Fe- 4.0 and Mn 0.95 mg $Kg^{-1}$, respectively. Treatments viz. $T_1$-RFD ($N_{120}$ $P_{60}$ $K_{60}$), $T_2$- SSNM ($N_{150}$ $P_{60}$ K40, $ZnSO_4$ 25, $FeSO_4$ 25 and $MnSO_4$ 25 Kg $ha^{-1}$) on the nutrient expert recommendation, $T_3$ SSNM (1/2N as basal and remaining N on the basis of leaf color chart), $T_4$ = $T_2$ minus nitrogen, $T_5$ = $T_2$ minus phosphorus, $T_6$ - $T_2$ minus potassium, $T_7$ absolute control and $T_8$ farmers fertilizer practices ($N_{150}$ $P_{30}$ $K_0$ Kg $ha^{-1}$). All the treatments were evaluated in randomized block design with three replications. 21 days old seedlings of 'NDR-359' rice was transplanted on first week of July in each years with 20 x 10 cm row to row and plant to plant spacing. The half dose on nitrogen and full doses of P, K, $ZnSO_4$, $FeSO_4$ and $MnSO_4$ were applied as basal at the time of transplanting through urea, S.S.P., M.O.P., $ZnSO_4$, $FeSO_4$ and $MnSO_4$, respectively and remaining nitrogen was applied in two equal splits at maximum tillering and panicle initiation stage or on the basis of leaf color chart as per treatments. Agronomical cultural practices such as irrigation, weeding and plant protection measures have been performed as per requisited. At maturity of rice grain and straw yield were recorded. Grain and straw samples were analyzed for their nitrogen content by modified Kjddahl method (Jackson 1973), phosphorus was determined by vanado molybdate yellow colour method and potassium by flame photometer in di-acid digest. Zinc in di-acid digest was estimated on atomic absorption spectrophotometer (Lindsay and Norvell, 1978). Available nitrogen was determined by the procedure (Subbiah and Asija, 1956).

## 3. RESULTS AND DISCUSSION

**Impact of treatments on the yield and yield attributing characteristics**

It is obvious from the data (Table 1) that grain and straw yield of rice 'NDR-359' along with yield attributing characteristics viz. panicles $m^{-2}$, tillers $m^{-2}$, filled grains $panicle^{-1}$, panicle weight, 1000-grain weight, plant height and panicle length under the influence of various treatment significantly increased over absolute control. The mean grain and straw yield of rice varied from 2.44 to 6.10% and 3.045 to 7.609 t $ha^{-1}$, respectively. The mean values of yield components viz. panicles $m^{-2}$, tillers $m^{-2}$, number of filled grain $panicle^{-1}$, panicle weight, 1000-grain weight, plant height and length of panicles differed from 213 to 317, 288 to 331, 111 to 171, 2.28 to 3.12 g, 27.02 to 28.73 g, 86.3 to 112.2 cm and 20.3 to 27.5 cm, respectively. Although in general addition of fertilizer nutrients i.e. $N_{150}$ $P_{60}$ $K_{40}$, $FeSO_4$ - 25, $ZnSO_4$ - 25 and $MnSO_4$ - 25 Kg $ha^{-1}$ as SSNM basis responded significantly higher on yield and yield attributing parameters ($T_2$) over absolute control. Full doses of all nutrients were applied as basal at time of transplanting of seedling

except nitrogen, which was applied in three equal splits at transplanting, maximum tillering and panicle initiation stages of rice crop. However, application of P, K, Zn, Mn and Fe full doses as basal except nitrogen which was applied half as basal and remaining half on the basis of leaf color chart ($T_3$) recorded maximum grains and straw yield as well as all yield attributing characteristics but could not reach the level of significance than that of $T_2$ treatment. Application of $N_{120}$ $P_{60}$ $K_{60}$ Kg ha$^{-1}$ as RFD showed remarkable higher yield and yield attributes of rice than that of absolute control ($T_7$) and farmers fertilizer dose viz. $N_{l50}$ $P_{30}K_0$ Kg ha$^{-1}$ ($T_8$).

**Table 1** Impact of site specific nutrient management on the yield and yield attributing characteristics of rice (Mean value of 03 years)

| Treatments | Grain yield (t ha$^{-1}$) | straw yield (t ha$^{-1}$) | Pooled increase over control (%) | Biomass concentration (g) hill$^{-1}$ | | Tiller (m$^{-2}$) | Panicles (m$^{-2}$) | Filled grain panicle$^{-1}$ | Panicle weight (g) | Test weight/ plant 1000-grain (g) | Plant height (cm) | Panicle length (cm) | Net return (Rs. ha$^{-1}$) | B:C ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 30 DAT | 60 DAT | | | | | | | | | |
| $T_1$ | 5.39 | 6.78 | 123.70 | 4.98 | 24.00 | 308.3 | 298.6 | 156.0 | 2.78 | 27.79 | 109.8 | 25.5 | 30382 | 1.9 |
| $T_2$ | 5.87 | 7.39 | 143.70 | 5.56 | 27.24 | 323.5 | 317.7 | 168.5 | 3.05 | 27.48 | 111.3 | 27.2 | 43487 | 2.4 |
| $T_3$ | 6.13 | 7.61 | 152.50 | 5.67 | 28.90 | 331.2 | 326.5 | 172.3 | 3.12 | 27.12 | 112.2 | 27.5 | 44075 | 2.6 |
| $T_4$ | 3.25 | 4.02 | 52.00 | 3.98 | 14.72 | 266.6 | 246.4 | 116.6 | 2.53 | 27.97 | 91.7 | 23.6 | 32690 | 1.3 |
| $T_5$ | 4.59 | 5.71 | 89.30 | 4.30 | 17.63 | 285.2 | 273.3 | 132.4 | 2.50 | 28.48 | 103.5 | 24.2 | 35234 | 1.9 |
| $T_6$ | 5.5 | 6.95 | 130.10 | 4.58 | 20.61 | 310.4 | 303.1 | 161.6 | 2.92 | 28.73 | 110.4 | 25.8 | 39570 | 1.7 |
| $T_7$ | 2.40 | 3.04 | - | 3.29 | 10.58 | 238.6 | 213.8 | 111.8 | 2.28 | 27.02 | 86.3 | 20.3 | 2312 | 0.6 |
| $T_8$ | 4.91 | 6.14 | 103.10 | 4.18 | 19.23 | 301.5 | 289.3 | 150.2 | 2.65 | 27.88 | 105.6 | 24.7 | 28219 | 1.6 |
| G. Mean | 4.76 | 5.95 | - | 4.57 | 20.36 | 295.66 | 283.59 | 146.17 | 2.74 | 27.86 | 103.8 | 24.8 | - | - |
| CD 5% | 0.246 | 0.312 | - | 0.27 | 1.68 | 11.16 | 10.55 | 6.23 | 0.09 | 0.52 | 2.70 | 1.85 | - | - |

The omission of nitrogen, phosphorus and potassium alone in particular treatment noticed remarkable decreasing response on grain and straw yield along with yield components of rice. The effect of nitrogen omission was more pronounced followed by phosphorus and potassium on yield and yield parameters of rice. By and large, imbalance use of fertilizer nutrients by farmers under treatment ($T_8$) corresponding above yield and yield parameters recorded lower values. These findings have close conformity with those reported by Tripathi *et al.,* (2014) and Tripathi *et al.,* (2016).

Although, in general the biomass accumulation in rice plants under the influences various treatments significantly differed than that of control condition at both stages viz., 30 DAT and 60 DAT. Maximum biomass 5.67 and 28.90 g hill$^{-1}$ at 30 DAT and 60 DAT, respectively was determinate in that plot which received full doses of P, K, Zn, Fe and Mn along with 50% N as basal and remaining 50% N in two equal splits applied as per leaf color apart indicated ($T_3$) followed by $T_2$ and $T_1$.

**Impact of treatments on the concentration of nutrients**

It is clear from the data presented in Table 2 that concentration of nitrogen, phosphorus, potassium and zinc in grain of rice 'NDR-359' under the influence of various treatments ranged from 1.262 to 1.407%, 0.348 to 0.382%, 0.448 to 0.476% and 22.35 to 24.65 mg kg$^{-1}$, respectively. On other hand, the percentage concentration of nitrogen (0.825-0.870), phosphorus (0.135 to 0.154), potassium (1.615-1.666) and zinc (16.52-18.69 mg kg$^{-1}$) with mean value of 0.850%, 0.146, 1.642% and 18.00 mg kg$^{-1}$, respectively, although, concentration of aforesaid nutrients except potassium were higher in grain of rice than that straw under each treatments during all the three khraif season. Maximum concentration of nitrogen, phosphorus, potassium and zinc in grain 1.407%, 0.382%, 0.476% and 24.65 mg kg$^{-1}$ and in straw 0.870%, 0.154%, 1.666% and 18.69 mg kg$^{-1}$ were recorded in that treatment which received 50% N with full dose of $P_{60}K_{60}$ZnSO4-25, FeSO4-25 and $MnSO_4$-25 kg ha$^{-1}$ as basal at the time of transplanting of rice seedling and remaining half nitrogen was top dressed as per leaf color chart indicated ($T_3$) followed by $T_2$ and $T_1$. Lowest concentration of N P K and Zn in grain and straw were determined in absolute control condition (Table 2). Omission of N, P and K in particular plots showed markedly decreasing impact on their concentration on both grain and straw of rice NDR-359. These findings have close conformity with those reported by Tripathi *et al.,* 2014 and Tripathi *et al.,* 2016. Imbalance use of all major and micro plant nutrients through farmers without testing nutrients availability in their particular fields caused poor nutritional status of rice grain and straw resulting yield and up to desirable level (Tripathi *et al.,* 2012 and Tripathi *et al.,* 2013).

**Table 2** Impact of site specific nutrient management on the percentage in the percentage concentration of plant nutrient in rice (Mean value of 03 Years)

| Treatments | In grain | | | | In straw | | | |
|---|---|---|---|---|---|---|---|---|
| | Nitrogen (%) | Phosphorus (%) | Potassium (%) | Zinc (mg $kg^{-1}$) | Nitrogen (%) | Phosphorus (%) | Potassium (%) | Zinc (mg $kg^{-1}$) |
| $T_1$ | 1.369 | 0.360 | 0.462 | 24.22 | 0.850 | 0.150 | 1.653 | 18.50 |
| $T_2$ | 1.388 | 0.374 | 0.471 | 24.65 | 0.868 | 0.153 | 1.664 | 18.68 |
| $T_3$ | 1.407 | 0.382 | 0.476 | 24.65 | 0.870 | 0.154 | 1.666 | 18.69 |
| $T_4$ | 1.357 | 0.358 | 0.458 | 23.88 | 0.838 | 0.143 | 1.638 | 17.69 |
| $T_5$ | 1.360 | 0.3.54 | 0.465 | 24.15 | 0.844 | 0.132 | 1.644 | 18.20 |
| $T_6$ | 1.370 | 0.365 | 0.452 | 24.28 | 0.854 | 0.152 | 1.630 | 18.48 |
| $T_7$ | 1.262 | 0.348 | 0.448 | 22.35 | 0.825 | 0.135 | 1.615 | 16.52 |
| $T_8$ | 1.367 | 0.359 | 0.464 | 23.46 | 0.845 | 0.143 | 1.626 | 17.25 |
| G. Mean | 1.360 | 0.362 | 0.462 | 23.95 | 0.850 | 0.146 | 1.642 | 18.00 |
| CD 5% | 0.023 | 0.009 | 0.010 | 0.46 | 0.031 | 0.022 | 0.014 | 0.23 |

**Impact of Treatments on the uptake of nutrients**

Data pertaining nutrients uptake are illustrated in table 3. It is evident from the results obtained from the experiment that uptake of nitrogen, phosphorus, potassium and zinc by rice grain varied from 30.79 to 85.84 kg $ha^{-1}$, 8.49 to 23.31 kg $ha^{-1}$, 10.93 to 29.04 kg $ha^{-1}$ and 54.53 to 150.38 kg $ha^{-1}$ with mean value of 65.13, 17.34, 22.05 kg $ha^{-1}$ and 114.71 g $ha^{-1}$, respectively. The uptake of aforesaid nutrients by rice straw ranged from 25.12 to 66.20 kg $ha^{-1}$, 4.11 to 11.71 kg $ha^{-1}$, 49.18 to 126.77 kg $ha^{-1}$ and 50.30 to 142.21 g $ha^{-1}$ with general average value of 50.79 kg $ha^{-1}$, 8.78 kg $ha^{-1}$, 95.96 kg $ha^{-1}$ and 108.19 g $ha^{-1}$, respectively. Although, application of N, P, K and Zn on the basis of RDF ($T_1$), SSNM on nutrient expert report ($T_2$) and SSNM on leaf color chart ($T_3$) significantly increased the uptake these nutrients than that of absolute control but impact was more pronounced in that treatment which received ½ N with full doses of P, K, Zn, Fe and Mn as basal at the time of transplanting and remaining help in two equal splits as per leaf color chart indicated ($T_3$). Lowest uptake of N P K and Zn were recorded in control condition. Omission of N P and K in potassium plots showed their detrimental response the availability of these nutrients as well as their uptake by both grain and straw of rice. In general, imbalance use of $N_{150}P_{30}K_0Zn_0Fe_0$ and $Mn_0$ by farmers cause poor availability of nutrients, resulting lower uptake of NPK and Zn rice grain and straw. Therefore, maximizing the production as well as nutrients uptake by rice integrated plant nutrient through IPNSSN SSNM and IPNM is necessary and suggested to farmers (Mishra *et al.,* 2015 and Tripathi *et al.,* 2014).

**Table 3** Impact of site specific nutrient management on nutrients uptake by grain and straw of rice (Mean value of 03 Years)

| Treatments | Nitrogen (kg $ha^{-1}$) | | | Phosphorus (kg $ha^{-1}$) | | | Potassium (kg $ha^{-1}$) | | | Zinc (g $ha^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grain | Straw | Total | Grain | Straw | Total | Grain | Straw | Total | Grain | Straw | Total |
| $T_1$ | 73.75 | 57.67 | 131.42 | 19.39 | 10.18 | 24.57 | 24.89 | 112.16 | 137.05 | 130.50 | 125.52 | 256.02 |
| $T_2$ | 81.38 | 64.15 | 145.53 | 21.93 | 11.31 | 33.24 | 27.61 | 122.99 | 150.60 | 144.52 | 138.06 | 282.58 |
| $T_3$ | 85.84 | 66.20 | 152.04 | 23.31 | 11.72 | 35.03 | 29.04 | 126.77 | 155.81 | 150.38 | 142.21 | 292.59 |
| $T_4$ | 43.61 | 33.67 | 77.28 | 11.51 | 5.75 | 17.26 | 14.72 | 65.81 | 80.53 | 76.75 | 71.09 | 147.84 |
| $T_5$ | 62.33 | 48.20 | 110.53 | 16.22 | 7.82 | 24.04 | 21.31 | 93.89 | 115.20 | 110.68 | 103.94 | 214.62 |
| $T_6$ | 76.24 | 59.39 | 135.63 | 20.31 | 10.57 | 30.88 | 25.15 | 97.05 | 122.20 | 135.12 | 128.51 | 263.63 |
| $T_7$ | 30.79 | 25.12 | 55.91 | 8.49 | 4.11 | 12.60 | 10.93 | 49.18 | 60.11 | 54.53 | 50.30 | 104.83 |
| $T_8$ | 67.13 | 51.89 | 174.93 | 17.63 | 8.78 | 26.41 | 22.79 | 99.85 | 122.64 | 115.21 | 105.93 | 221.14 |
| G. Mean | 65.13 | 50.79 | 115.92 | 17.34 | 8.78 | 26.12 | 22.05 | 95.96 | 118.01 | 114.71 | 108.19 | 222.90 |
| CD 5% | 2.23 | 1.97 | - | 0.57 | 0.32 | - | 0.78 | 2.78 | - | 2.95 | 2.87 | - |

**Impact on soil health**

It is palpable from the data (Table 4) that soil health parameters of experimental soil after harvesting of the experimental rice crop such as pH, E.C., organic carbon, available N, $P_2O_5$, $K_2O$ and zinc are illustrated in aforesaid table showed that pH, E.C., organic carbon, available N, $P_2O_5$, $K_2O$ and zinc varied from 7.50-7.58, 0.70-0.85 d $Sm_{-1}$, 4.58 to 4.94 g $kg^{-1}$, 231.53 to 248.5 kg $ha^{-1}$, 17.67 to 20.90 kg $ha^{-1}$, 164.00 to 177.77 kg $ha^{-1}$, and 0.35 to 0.55 mg $ha^{-1}$, with mean value of 7.54, 0.76 $dSm^{-1}$, 4.83 g $kg^{-1}$, 238.52 kg $ha^{-1}$, 19.84 kg $ha^{-1}$, 172.96 kg $ha^{-1}$, and 0.49 mg $ha^{-1}$ respectively. Balance use of nitrogen, phosphorus, potassium along with micronutrients viz., zinc, iron and manganese on the soil test basis as site specific nutrient management on nutrient expert

recommendation recorded more improvement on the physico-chemical characteristics of experimental soil. However, omission of nitrogen, phosphorus and potassium in particular treatments showed decreasing affect on their availability in such plots. The availability of a foresaid nutrients were observed in absolute lowest control plots. In general, treatments response on the soil health of experimental site could not observe any definite trends. Imbalance use of fertilizer nutrients under farmer fertilizer practices under irrigated rice ecosystem could not show remarkable beneficial improvement in soil health. These findings are comparable to those reported by Sharma *et al.* (2013) and Tripathi (2013).

**Table 4** Impact of site specific nutrient management on the soil health (Mean value of 03 Years)

| Treatments | pH (1:2.5) | EC ($dSm^{-1}$) | Organic carbon ($g\ kg^{-1}$) | Available nitrogen ($kg\ ha^{-1}$) | Available phosphorus ($kg\ ha^{-1}$) | Available potassium ($kg\ ha^{-1}$) | Available Zinc ($mg\ kg^{-1}$) |
|---|---|---|---|---|---|---|---|
| $T_1$ | 7.52 | 0.79 | 4.58 | 240.37 | 20.00 | 175.00 | 0.48 |
| $T_2$ | 7.50 | 0.85 | 4.92 | 246.93 | 20.90 | 177.77 | 0.54 |
| $T_3$ | 7.51 | 0.872 | 4.941 | 248.5 | 20.50 | 177.43 | 0.55 |
| $T_4$ | 7.57 | 0.70 | 4.76 | 232.53 | 19.83 | 171.33 | 0.53 |
| $T_5$ | 7.56 | 0.72 | 4.79 | 235.43 | 17.67 | 173.70 | 0.52 |
| $T_6$ | 7.55 | 0.74 | 4.89 | 242.37 | 20.30 | 164.00 | 0.50 |
| $T_7$ | 7.53 | 0.76 | 4.82 | 238.33 | 20.20 | 173.37 | 0.46 |
| $T_8$ | 7.58 | 0.73 | 4.71 | 224.73 | 19.61 | 171.10 | 0.35 |
| G. Mean | 7.58 | 0.76 | 4.83 | 238.52 | 19.84 | 172.96 | 0.49 |
| CD 5% | 0.05 | 0.06 | 0.09 | 2.83 | 0.92 | 1.92 | 0.02 |

**Economics**

On the perusal of data illustrated in Table 1 clearly revealed that net returns with benefit: cost ratio varied from Rs. 2312 to 44075 with 0.6 to 2.6 from 'NDR-359' rice under influence of various treatments. Application of half dose of nitrogen and full doses phosphorus, potassium, zinc sulphate, ferrus sulphate and manganese sulphate as basal at the time of transplanting of rice seedlings under site specific nutrient management practice and remaining half nitrogen was foliar feeded on leaf colour chart basis, showed maximum net return with 2.6 B:C ratio ($T_3$) followed by $T_2$, $T_6$, $T_5$, $T_4$ and $T_1$. Lowest net return (Rs. 2312) and benefit: Cost ratio (0.6) was recorded in absolute control condition. Although, in general, omission of nitrogen phosphorus and potassium in particular plots noticed decreasing response in net returns and B:C ratio. The response of nitrogen omission was more pronounced than phosphorus and potassium. Imbalanced use of fertilizer nutrients under farmers fertilizer practice caused poor net return (Rs. 28219) with 1.6 B:C ratio. The markedly enhancement in net returns by application of fertilizer nutrients both major and minor in rice crop under SSNM and LCC might be due to positive and integrated effect on grain and straw yield. These results have close conformity with those reported by Singh and Tripathi (2018), and Tripathi *et al.,* (2015).

## 4. CONCLUSION

I can be concluded from the results that integrated use of nitrogen, phosphorus, potassium, zinc, iron and manganese through prilled urea, S.S.P., MOP, $ZnSO_4$, $FeSO_4$ and $MnSO_4$ @ 150:6:60:25:25 and 25 kg $ha^{-1}$, respectively on the basis of SSNM in particular irrigated rice ecosystem was found optimum for production of grain and straw nutritional status of rice grain as well as nutrients uptake not returns and improvement of soil health in regard nutrients availability and other physic-chemical characteristics of experimental. Imbalance use of major and micro nutrient either omission of N, P, K or though farmers fertilizer practices causes poor nutrition status/ availability of nutrients resulting adverse impact on productivity of rice grain in such type of irrigated rice soil.

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**Peer-review:** External peer-review was done through double-blind method.

**Data and materials availability:** All data associated with this study are present in the paper.

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